

Traditional: 02-01

Themed: 09-01

Freefall

What is “g”?

- g is the acceleration of gravity
- The value is -9.8 m/s^2 (you need to memorize this because it comes up SO MANY times!)
- Same symbol for magnitude of acceleration, so need to know context. Example:
 - Use 9.8 for scalar calculations, like energy or speed
 - Use -9.8 for vector calculations, like velocity or force

Reaction time

- It takes a minimum 80 ms (milliseconds) for the brain to process something it sees
- It takes another 35 ms for the body to begin moving after the brain processes, a total of 115 ms to press a button after a visual stimulus is given (about $1/10^{\text{th}}$ of a second)
- Don't need to know these numbers exactly, need to know concepts: real graphs, concepts

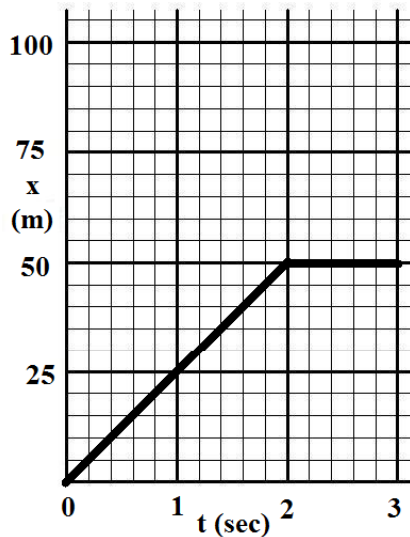
Anticipation

- There is no lag time with anticipation
- Example: a count down, 3, 2, 1, 0.....
 - You have an expectation of when zero will be said based on a timed pattern – you don't react to hearing "zero", THEN processing the meaning of the sound THEN responding to it
- See the difference between anticipation and reaction time?

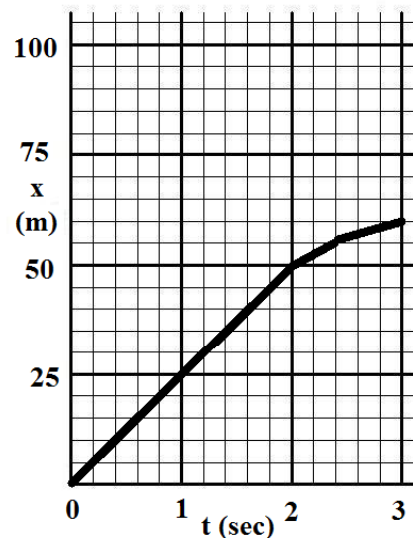
Graphical example

- Suppose you're driving in your car and see a yellow light and decide you must stop. Which plot is consistent with driving for 2.0 seconds, then the green light turns yellow (at 2.0 seconds)? How do you know?
- Do you stop instantly when brakes are applied, or is there a "braking distance"?
- Do any of these resemble a car hitting a brick wall rather than braking?

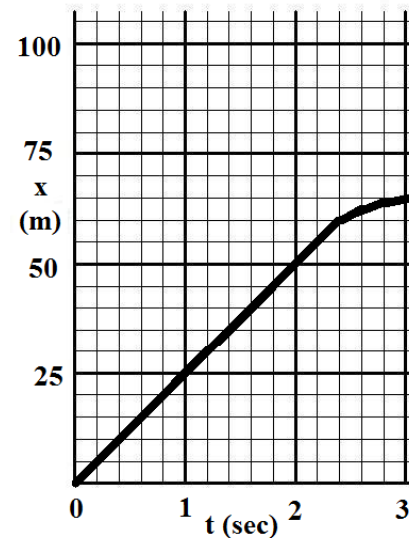
Driver reacting to yellow light



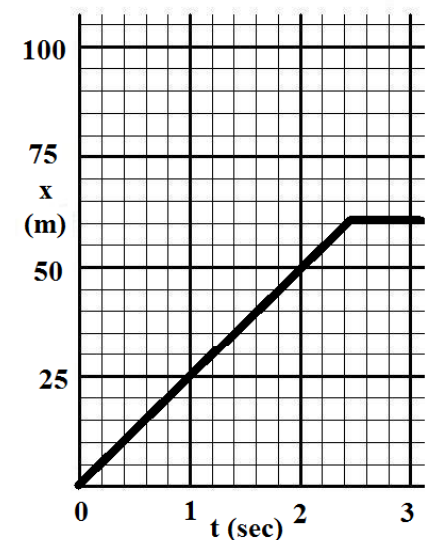
Driver reacting to yellow light



Driver reacting to yellow light



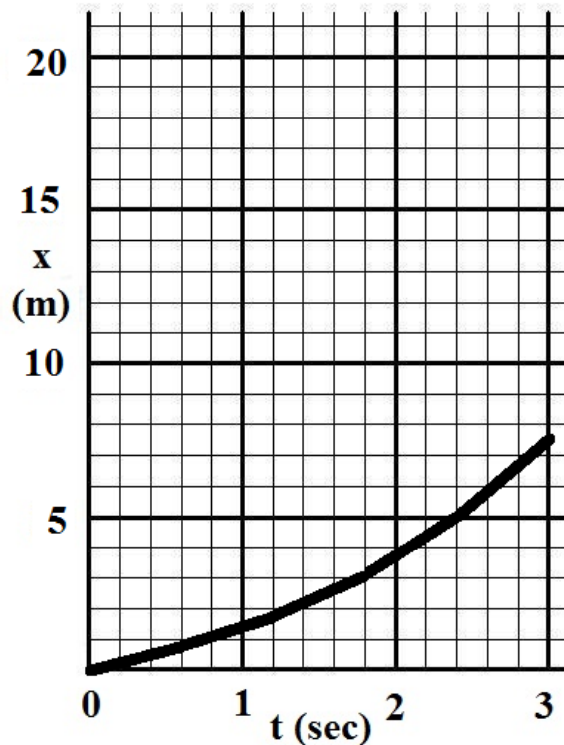
Driver reacting to yellow light



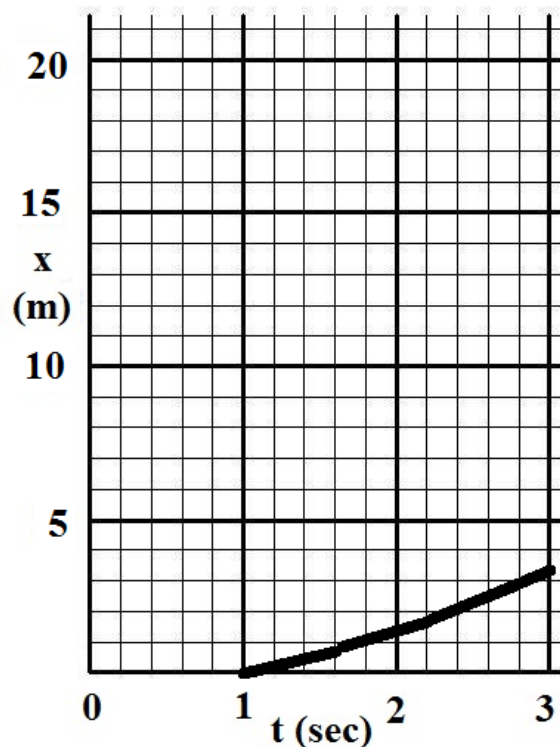
Graphical example

- Did yours look like any of these?
- Which is most realistic? Why?
- Could you do a velocity plot too? An acceleration plot?

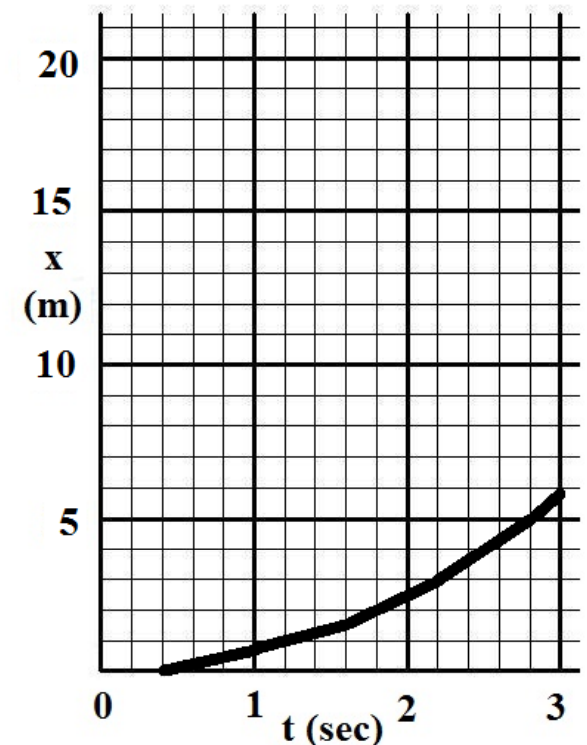
Speedskater reacting to gun sound



Speedskater reacting to gun sound



Speedskater reacting to gun sound



Freefall definitions

Freefall – When the only force on a falling object is gravity (ideal case)

- assume no air resistance

Terminal Velocity – The steady-state speed a falling object reaches air resistance becomes as strong as gravity

Air resistance – force opposing a moving object by air molecules

Drag – air resistance

Hang time – The total time spent in the air, usually by someone jumping up

Up time – Half the hang time, the portion going up

Down time – Half the hang time, the portion going down

Symbols – g , a , Δt , v_i , v_f and Δx (acceleration of gravity on earth, acceleration in general, change in time, initial velocity or speed, final velocity or speed, distance or displacement (change in position))

Nifty equations of motion

- Systematic means of solving motion problems
- Eliminates searching for equations
- Still linear motion
 - Single direction is still called “X”
 - We’ll have modified version for two-dimensional motion (next unit)
 - Next unit horizontal will be X and vertical will be Y
- Five variables:
 - 3 are knowns
 - 1 is an unknown
 - 1 variable is not part of problem: “sad face”
 - Sad face determines the equation to use

Equation	a	t	v _i	v _f	Δx
$\Delta x = \frac{(v_i + v_f)}{2} t$	☹	✓	✓	✓	✓
$v_f^2 = v_i^2 + 2a\Delta x$	✓	☹	✓	✓	✓
$\Delta x = v_i t + \frac{1}{2} a t^2$	✓	✓	✓	☹	✓
$v_f = v_i + a t$	✓	✓	✓	✓	☹

Assumptions

Assumptions you need to know (write these in your notebook and commit them to memory!)

- $g = -9.8 \text{ m/s}^2$ (you're on earth unless the problem specifically says differently)
- $v_i = 0$ for any object dropped (or, next unit thrown horizontally)
- symmetry: same time up as down, same speed up as down, same height up as down
- object tossed upward: $v = 0$ at highest point, acceleration never changes or "stops"
- easiest to use downward half + symmetry to find time airborne (half of hangtime)

Equation	a	t	v_i	v_f	Δx
$\Delta x = \frac{(v_i + v_f)}{2} t$	☹	✓	✓	✓	✓
$v_f^2 = v_i^2 + 2a\Delta x$	✓	☹	✓	✓	✓
$\Delta x = v_i t + \frac{1}{2} a t^2$	✓	✓	✓	☹	✓
$v_f = v_i + a t$	✓	✓	✓	✓	☹

t

Time to try some!

- Ryan takes up cliff diving. He steps off of a 10 m ledge and heads toward the blue ocean waters. How much time will he be in the air?
- Ria jumps off of an 80 m tall moon crater in her spacesuit to the ground below. She impacts the lunar surface at 8.944 m/s. What is the acceleration due to gravity on the moon?

Equation	a	t	v _i	v _f	Δx
$\Delta x = \frac{(v_i + v_f)}{2} t$	☹	✓	✓	✓	✓
$v_f^2 = v_i^2 + 2a\Delta x$	✓	☹	✓	✓	✓
$\Delta x = v_i t + \frac{1}{2} a t^2$	✓	✓	✓	☹	✓
$v_f = v_i + a t$	✓	✓	✓	✓	☹